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ABSTRACT

A research priorities study conducted during 1976 generated 35 science education research statements which were rated by the membership on a priorities scale. The purpose of this study was to condense this set of 35 statements into factors which were inherent to the set. A second purpose was to collapse the statements into fewer meaningful and manageable groups. The priority rankings given to each item by the respondents were analyzed through four factor analytical procedures. The first analysis indicated that there were six factors with eigenvalues greater than 1 underlying the 35 research statements. When the number of factors which could develop was limited to six, the nature of one factor changed somewhat because of a shift in the item loadings. When only five factors were allowed to develop, this factor disappeared and the items in it loaded on several other factors. The five factors which remained were identifiable in the initial analysis and the six-factor limited analysis. When the factor was limited to four, the nature of the factors was much more ambiguous because of shifting items. (Author/MH)

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A FACTOR ANALYTICAL STUDY OF THE RESEARCH PRIORITIES OF SCIENCE EDUCATORS

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A FACTOR ANALYTICAL STUDY OF THE RESEARCH PRIORITIES OF SCIENCE EDUCATORS

Introduction

At the 1976 Annual Meeting, the National Association of Research on Science Teaching (NARST) authorized a survey of the research priorities of its membership. A three phase Delphi study was undertaken in the spring and summer of 1976. All NARST members were requested to nominate three areas of high research priority. A total of seven hundred twenty-nine nominations were returned. These specific nominations were classified into thirty-five generic categories describing broad areas of research focus.

A list of the thirty-five generic statements was then distributed to all NARST members with a request to rate each on a priority scale from 1 to 10, with 1 being high priority. Three hundred and twenty-seven responses were received. Measures of central tendency and dispersion were calculated from these data on the priority ratings for each statement. Thus information was then returned to all respondents along with their original ratings. In this final phase, respondents reevaluated their original responses in light of the group ratings. Two hundred and nine science educators returned this information.

The results of this reevaluation in the third phase were the final ratings of research priority. Mean ratings for the thirty-five statements ranged from 2.5 to 8.1. As expected in a Delphi Study the variance of responses decreased in the final round. A second finding in the final round was the increase in rating of high rated statements and a decrease in the rating of low-rated areas.

A problem associated with the interpretation of these results is that the means of the highest rated items were so similar that differences among

the ratings could not be discriminated. A second, and obvious, difficulty in interpreting the results of the study was the large numbers of items rated. The task of comparing so many similar, closely-rated ideas was conceptually difficult, if not fruitless.

Efforts to facilitate interpretation resulted in attempts to reduce the thirty-five areas to a more manageable number. For example, various categorizations were created (i.e. pure vs. applied, classroom strategies vs. less practical, etc.). Each system undoubtedly reflected the biases of its creator. The most defensible and empirically sound means for partitioning the thirty-five priorities into sets was a factor-analytic procedure. The problem addressed in this study was three-fold:

1. to reduce the thirty-five statements to fewer more manageable and interpretable groups
2. to identify factors that exist among the thirty-five areas rated by NARST members
3. to compare the means of the mean priority ratings of statements in the factors identified.

Procedure

The priority ratings given to each item by the respondents were factor analyzed by principal component with iteration factoring. Factor extraction was initially controlled by selecting eigenvalues ≤1 and rotating through the use of Varimax procedures. In the initial extraction procedure, no restrictions were set on the number of factors which could develop above an eigenvalue of /1. The factor extraction procedure was then repeated but restricted to the development of six factors, the number of identifiable factors in the intial analysis. In subsequent analyses, the number of factors was restricted to five and then four in order to determine which factors were persistent and maintained their identity.

In order to compare the priority ratings of the factors, the means of all statements within a factor were averaged.

Results

The initial factor analysis resulted in the identification of 6 factors which, together, accounted for 83.7% of the variance in the final rankings of the science education research priorities. The high loading (.40 or greater) statements in each of the six were examined to interpret the nature of the factor. The following factors were named.

FACTOR I, Analyzing and Applying Learning Theory accounted for 36.2% of the total variance. Statements which loaded heavily on this factor relate to applying learning and cognitive development theory to concept formation, analyzing the relationship between subject matter and cognitive structure of the learner, and analyzing problem solving acquisition, retention and transfer skills.

FACTOR II, Conducting Needs Assessments accounted for 15.6% of the total variance. The heavy loading statements in this factor all dealt with needs assessment activities related to curriculum development.

FACTOR III, Social and Educational Pot Pouri accounted for 11.2% of the total variance. A variety of statements loaded heavily on this factor. These included an historical comparison of science teaching goals, the influence of political pressure on science instruction, characterizing the reluctant science teacher, analyzing the effects of the NSF.

FACTOR IV, Determining the Effects of Teaching and Attitudes on Learning accounted for 8.3% of the variance and included statements about researching teaching behaviors that facilitate science learning, identifying the characteristics which predict successful achievement in science.

FACTOR V, Developing and Evaluating Interdisciplinary Curricula accounted for 5.9% of the variance and was composed of two statements on developing and evaluating instructional materials.

FACTOR VI, Validating Teacher Training Strategies accounted for 6.5% of the total variance. Heavy loading statements in this factor related to the identification and validation of science teacher education strategies to assist in the preservice and inservice acquisition of teaching skills.

When the total number of factors which could develop was limited to six, the nature of Factor V changed somewhat because of a shift in the statement loadings. When only five factors were allowed to develop, Factor VI disappeared and the statements in it loaded on several other factors. The five factors which remained (I, II, III, IV and V) were identifiable in both the intial analysis and the six-factor limited analysis.

Table 1 is a list of the five factors from the restricted analysis with the statements which compose them and their factor loadings. The mean of the mean ratings of all statements within a factor are included as the left column.

Conclusions

The purposes of this factor analytical study were to reduce the thirty-five statements to more manageable and interpretable science education research priorities and to compare the mean priority ratings of the factors identified.

There does appear to be some difference in the priority ratings of the factors when the mean ratings of statements within a factor are averaged. An inspection of Table 1 reveals the highest research priority (3.18) as viewed by the membership of the NARST is represented by Factor IV--DETERMINING THE EFFECTS OF ATTITUDES AND TEACHING ON LEARNING. ANALYZING AND APPLYING LEARNING THEORY (Factor I) and CONDUCTING SCIENCE CURRICULUM NEEDS ASSESSMENTS

(Factor II) are essentially tied for number two priority with mean ratings of 3.41 and 3.42. INTERDISCIPLINARY CURRICULUM DEVELOPMENT AND EVALUATION (Factor IV) was rated as a slightly lower priority (4.05).

Factor III--SOCIAL AND EDUCATIONAL POT POURI--is an interesting and somewhat undefineable set of statements. The seven heavy loading statements do not seem to possess any easily conceptualized relationship. The fact that the priority rating of the factor is the lowest of the five (5.35) is probably a clue to the identity of the factor. That is, unlike the other factors which seem to be composed of statements related to a common research theme, Factor III represents a composite of low priority research areas in science education as perceived by the NARST membership.

The factor analytical procedures employed in this study proved to be very useful in the process of reducing and discriminating among many over-lapping priority ratings. The five factors are much easier to conceptualize than the 35 research priority statements as a whole.

The identification of these factors with their mean priority ratings should provide a basis for decisions related to the commitment of resources in future science education research.

TABLE 1

The Thirty-five Science Education Research Priorities As They Loaded On Five Factors Identified Through Restricted Factor Analysis Procedures

FACTOR I ANALYZING AND APPLYING LEARNING THEORY

Mean Factor Rating	Factor Loading	Statements
	.78	Application of learning and cognitive development theories to concept formation.
	.65	Analysis of relationship between discipline (subject matter) structure and cognitive structure of the learner.
	.63	Analysis of strategies for acquisition, retention and transfer of problem solving (critical thinking or inquiry skills) in students.
	.59	Construction of a theory of science instruction.
	.58	Application of learning and cognitive development theories to classroom instruction.
$\bar{\bar{X}} = 3.41$	.41	Identification of factors which influence formation of attitudes in students, e.g., value clarification in environmental education, attitudes toward science and technology.
	.39	Definition and validation of goals of science instruction, e.g., balance between process and process objectives, philosophical and theoretical basis of science instruction, articulation of goals for students at all levels, K-16.
	.38	Identification and design of instructional materials in subject content areas for teachers essential to support successful science instruction.
	.36	Identification and development of teacher education strategies (inservice and preservice) designed to facilitate professional growth and concerns of teachers, including committment to continued growth.

FACTOR II CONDUCTING NEEDS ASSESSMENTS

Mean Factor Rating	Factor Loading	Statements
	.90	Needs assessment of current practices as a basis of decision making for the development of science curriculum and teacher education materials at junior high or middle school level.
	.81	Needs assessment of current practices as a basis of decision making for the development of science curriculum and teacher education materials at elementary level.
$\bar{\bar{X}} = 3.42$	.75	Needs assessment of current practices as a basis of decision making for the development of science curriculum and teacher education materials at senior high level.
	.60	Needs assessment of current practices as a basis of decision making for the development of science curriculum and teacher education materials at college level.
	.37	Identify what elements are essential in translating both research and development activities into classroom practice.

TABLE 1 Continued

FACTOR III SOCIAL AND EDUCATIONAL POTPOURRI

Mean Factor Rating	Factor Loading	Statements
	.58	Comparison of goals of science teaching today with those of 10-20 years ago as viewed by a variety of society's segments--e.g., parents, teachers, students, and teacher educators.
	.54	Analysis of residue effects of the NSF supported curriculum developments.
	.48	Analysis of factors which characterize the reluctant science teacher.
	.47	Influence of political and technological pressures on science instruction, science teacher needs manpower--e.g., public attitudes and science enrollments.
	.46	Analysis of effectiveness of instructional systems with specific goals and target populations--e.g., CBTE, PSI, Open Education, Mastery Learning, etc.
	.43	Identification of management skills needed for maintaining a viable learning classroom environment--e.g., discipline, grouping, bookkeeping skills.
$\bar{X} = 5.35$	.41	Description of current perceptions of middle school, high school and college graduates about the nature of life, matter and energy, about usefulness and desirability of alternative teaching modes and strategies.
	.33	Identification and validation of alternative evaluation schemes for teachers and pupils.
	.28	Analysis of decisions related to curriculum implementation--e.g., choosing, using and evaluating curriculum, including analysis of what science teachers see as key decisions.
	.27	Development of alternative instructional strategies for use with learners with special problems--e.g., EMR, bi-lingual, culturally deprived, non-reader, minorities, etc.

FACTOR IV DETERMINING THE EFFECTS OF ATTITUDES AND TEACHING ON LEARNING

Mean Factor Rating	Factor Loading	Statements
	.60	Relationship between motivation, attitudes and performance (in both students and teachers).
	.60	Analysis of classroom teaching behaviors that facilitate science learning.
	.50	Identification and validation of specific teacher characteristics and knowledge which relate to successful teaching styles using ethnographic approaches.
	.44	Identification and validation of teaching behaviors and instructional strategies that facilitate student self-concept, knowledge and attitudes.
$\bar{X} = 3.18$	.40	Identification of factors which influence formation of attitudes in students, e.g., value clarification in environmental education, attitudes toward science and technology.
	.39	Identification and validation of strategies to assist preservice and inservice teachers in acquiring specific teaching skills.
	.38	Identification of characteristics of a professionally competent and committed teacher.
	.37	Design of longitudinal studies to identify what kinds of gains are important to a variety of student populations.
	.26	Assessment or impact of non-school experiences on students' knowledge in science, mathematics, social studies, etc.

FACTOR V DEVELOPING AND EVALUATING INTERDISCIPLINARY CURRICULA

Mean Factor Rating	Factor Loading	Statements
$\bar{X} = 4.05$	.73	Development and evaluation of instructional materials which draw from and integrate more fully sciences, social sciences, and mathematics.
	.71	Development and evaluation of instructional materials which are integrated with non-science areas such as reading, language arts, fine arts, etc.